Snake/Salt River Basin

Snake River at Tetons

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Watershed Description

Three of the nation's major river systems have their headwaters in Wyoming: the Missouri, Colorado, and Columbia Rivers. These basins provide a natural basis for delineating aquatic conservation areas. Six major basins were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations (Figure 9). These areas are consistent with the aquatic ecosystems identified for freshwater biodiversity conservation worldwide by Abell et al. (2008). The watershed areas are also synonymous with aquatic zoogeographical units and ecological drainage units identified under The Nature Conservancy's (TNC) hierarchical classification framework (Higgins et al. 2005). The basins each include one to four sub-regions (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

The Snake/Salt River basin corresponds with the Upper Snake sub-region (HUC 1704). It includes two 6-digit HUCs: Snake Headwaters and Upper Snake River (Figure 9). Eight sub-basins (8-digit HUCs) and twenty-nine watersheds (10-digit HUCs) occur within this area. These watersheds span an area of about 5,100 square miles in northwestern Wyoming's Lincoln, Teton, Sublette, and Park counties. Land ownership is predominantly public with only 8% privately held. These private lands, however, tend to be vital for aquatic wildlife along the riparian corridors and spring streams of the Snake and Salt Rivers. Public land is primarily managed by the U.S. Forest Service (69%) and National Park Service (Grand Teton National Park, 21%).

Most of the Snake/Salt River basin is within the Utah-Wyoming Rocky Mountains terrestrial-based ecoregion, as defined originally by Bailey (1995) and adapted by The Nature Conservancy. Elevations range from over 13,770 feet in the Teton Range to about 5,600 feet where the Snake River exits the state at Palisades Reservoir. Landscapes have been shaped by glaciation and consist of steep to moderately steep mountains, jagged peaks above timberline, moderate to high gradient perennial streams in the mountains, and areas of high sediment loads and commonly boulder and cobble substrates. Several spring streams occur, particularly along the alluvial valley floors of the Snake and Salt Rivers, but also in foothill mountain locations and other areas where geologic strata channel water to the surface.

The geology of the region is complex, with the geologically young and active Teton Range on the west, the Yellowstone Plateau to the north, the volcanic Absarokas to the northeast, and the Gros Ventre Mountains to the east (Knight 1994). The fault block rise of the Precambrian Teton Range has been influencing the course of the Snake River for eons and continues to influence valley slope and channel pattern. High volumes of volcanic, glacial, and sedimentary material are contributed by tributaries from the north and east with their source in the Absaroka or Gros Ventre Mountains. Glacial outwash gravels and features such as kettles and outwash moraines are common and also influence stream channels. The southern portion of the watershed includes the Wyoming Range and the Salt River Range. An overthrust belt of sedimentary rock is erosive and supplies high amounts of material to the Greys River drainage.

The Snake/Salt River basin corresponds closely with the boundaries of Wyoming climate division 2 (Curtis and Grimes 2004). This climate division is by far the wettest climate division of the 10 climate divisions in Wyoming with the vast majority of precipitation falling during the coolest months as snow. The peak July temperature averages 59º F and is cooler than all other Wyoming climate divisions. The coldest month is January and averages about 20º F. Precipitation peaks in January and December (Curtis and Grimes 2004) and ranges from about 14 inches at low elevations to over 40 inches in alpine areas.

All eleven habitat types defined in this SWAP (e.g., sagebrush shrublands, riparian, etc.,) occur

in the Snake/Salt River basin and are based on combinations of Ecological Systems (ES) developed by NatureServe (Comer et al. 2003, NatureServe Explorer 2009). The determination and delineation of ES is based on land cover maps produced by the Northwest Gap Analysis Project (NWGAP 2010). Land cover mapping under NWGAP for the Snake/Salt River basin in Wyoming is entirely in USGS mapping zone 2. Of the 173 ES identified under NWGAP, 55 occur in the Snake/Salt River basin (excluding developed and open water classes). The most prevalent classes are associated with the montane subalpine (48%), mountain grasslands (20%) and the foothill shrublands (15%) habitat types. The Rocky Mountain Lodgepole Pine Forest is the most common ES in the montane subalpine habitat in the Snake/Salt River basin. Associated species assemblages, threats, and conservation actions of the montane subalpine and other habitats in this watershed are addressed in separate chapters of this SWAP.

Land use is primarily livestock grazing, timber production, irrigated cropland, and recreation (Chapman et al. 2004). Crop production is primarily alfalfa, small grains, and native hay and grass. Sprinkler-irrigated alfalfa is the most extensive crop produced in the Salt River basin, while mountain meadow native hay is grown in the Snake River basin mostly using flood irrigation with surface water diversions (Snake/Salt River Basin Water Plan Final Report 2003). The four municipalities in the watershed, Afton, Alpine, Thayne, and Jackson, all derive water from groundwater sources.

The Snake/Salt River basin includes the Snake River headwaters, Buffalo Fork, Gros Ventre, Greys, Hoback, and Salt Rivers among other tributaries. From an analysis of the 2010 Version 2.0 National Hydrological Database (NHD) at 1:100,000, there are approximately 4,900 miles of streams in the Snake/Salt River basin. This equates to a drainage density of nearly 1 stream mile per square mile land area. Over 80% of these stream miles are first or second order streams.

Major reservoirs in the basin are Jackson Lake, Grassy Lake, and Palisades Reservoir with active capacities of 847,000 acre feet (af), 15,172 af, and 1,200,000 af, respectively (Snake/Salt River Basin Water Plan Final Report, 2003). They are all managed by the U.S. Bureau of Reclamation. Major natural lakes include Shoshone Lake, Heart Lake, Lewis Lake, Jenny Lake, Leigh Lake, Two Ocean Lake, Emma Matilda Lake, and Lower Slide Lake.

The total annual runoff in the watershed is about 4,800,000 af at Palisades Reservoir (5,150 square mile drainage area) (Simonds 1996). Runoff patterns are typical of snowmelt-dominated systems, with high peak flows in June and lowest annual flows occurring in January. While the major Snake River tributaries are often turbid and high well into the summer during average or higher runoff years, the alluvial valleys along the Snake and Salt River corridors contain several spring-fed streams with more consistent annual flow patterns. The flatter gradient and more constant conditions of these spring streams provide fertile salmonid habitat for spawning and rearing.

Several waters in the region fall into the highest class (Class 1) under the Wyoming Department of Environmental Quality (DEQ) water quality classification. These include all waters in Grand Teton Park, the Snake River from the Wilson Bridge upstream, Fish Creek and its tributaries near Wilson, and Granite Creek. Waters in congressionally designated wilderness areas as of January 1, 1999 are also included under the Class 1 designation. Water quality in Flat Creek near Jackson is threatened by sediment and is on the 303(d) List (Wyoming Department Environmental Quality 2010). A lower reach of the Salt River and Stump Creek with high *E. coli* levels are also on the 303(d) List. Crow Creek drains Idaho areas with phosphate mines and has had high selenium levels measured in recent years (Wyoming Department of Environmental Quality 2010). Several streams in the region are prone to massive earthflow, especially the Hoback and Gros Ventre Rivers.

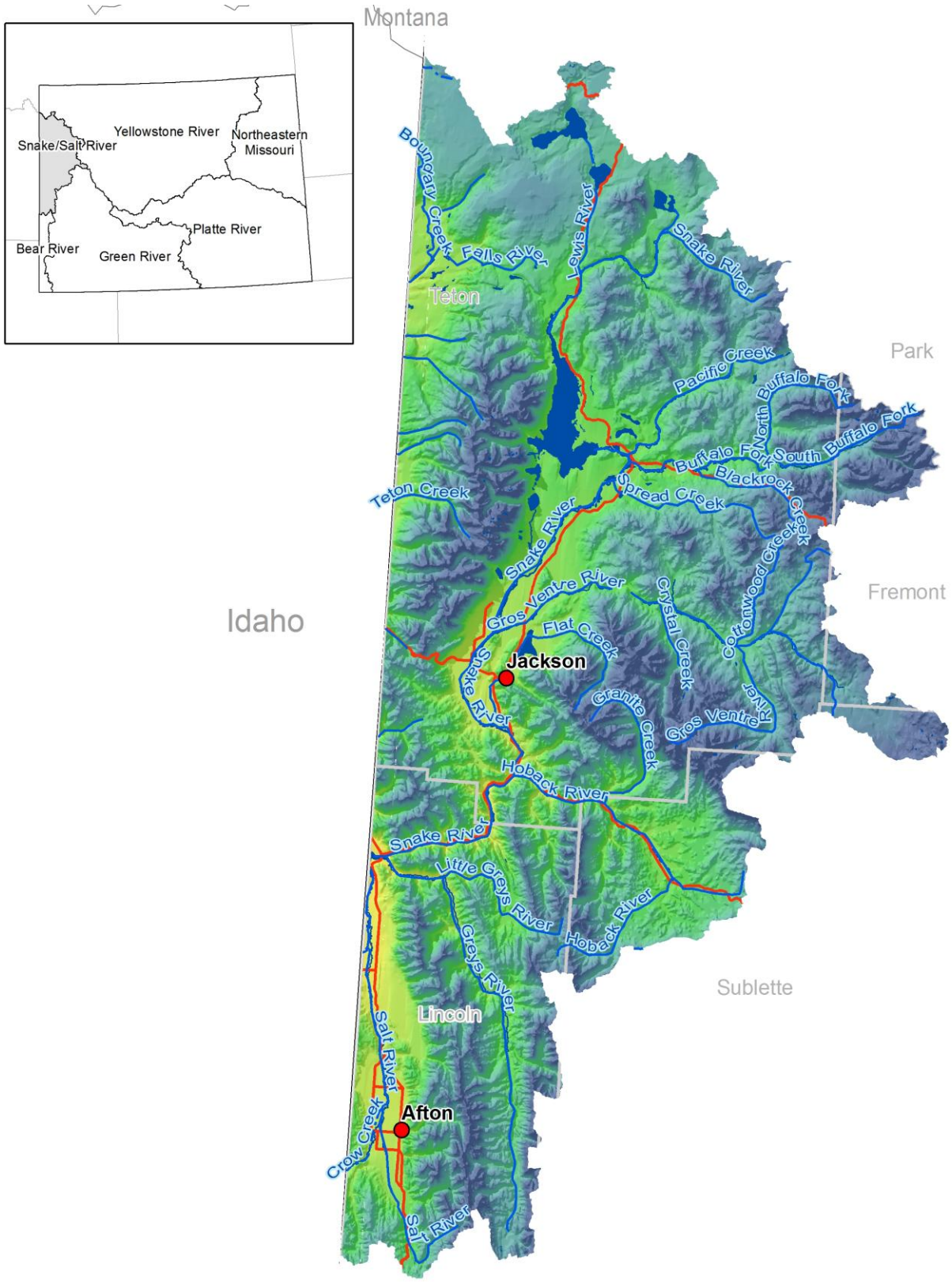

Figure 9. Snake/Salt River Basin.

Congress designated several Wild and Scenic Rivers in Wyoming in 2009, including parts of the Snake River, the Gros Ventre River, Hoback River, Buffalo Fork River, and several tributaries, totaling 407 miles. These protections recognize the scenic, recreational, and wildlife values of these streams and provide enhanced assurance that water quality and quantity will be maintained through development restrictions. The streams are far from pristine, however, especially the Snake River near Jackson Hole. The U.S. Army Corp of Engineers, Teton County, and private landowners constructed flood control levees in the 1950s and early 1960s along more than 24 miles of the Snake and Gros Ventre Rivers (U.S. Army Corp of Engineers 2000). Prior to construction, floodplain conditions included complex braided channels, wooded islands, and maintenance of diverse cottonwood stands. Post-construction, the river channel has become unstable and habitat conditions have degraded. In the late 1980s and early 1990s, Teton County, the Teton County Conservation District, and the U.S. Army Corps of Engineers proposed the Upper Snake River Restoration Project to rehabilitate and restore fishery and wildlife habitat lost to the levees.

Aquatic Wildlife

Fish

Twenty-one fish species are found in the basin. Cutthroat trout *Oncorhynchus clarkii* are represented by Yellowstone cutthroat *O. clarkii bouvieri* and a unique, unnamed subspecies, the fine-spotted cutthroat trout *O. clarkii ssp.* Thirteen species or subspecies are native to the basin, and nine are introduced. The WGFD recognizes and manages fine-spotted Snake River cutthroat separately from other cutthroats. This distinction has been made within the WGFD management program since 1955.

The native gamefish community is composed only of Snake River and Yellowstone cutthroat trout and mountain whitefish. The nonnative gamefish community consists of seven species of introduced salmonids and chars. The nongame fish community consists of ten native species and the introduced fathead minnow and white sucker.

Simon (1951) surveyed 10 sites in the Snake/Salt River basin and documented the presence of all known native species, as well as arctic grayling. The Snake River cutthroat has

Table 9. Fishes present in the Snake/Salt River basin. Species of Greatest Conservation Need (SGCN) are followed by an asterisk (*).

Native game	Native nongame	Nonnative game	Nonnative nongame
Mountain whitefish*	Bluehead sucker*	Bear River cutthroat trout	Fathead minnow
Snake River cutthroat trout*	Longnose dace	Brook trout	White sucker
Yellowstone cutthroat trout*	Mottled sculpin	Brown trout	
	Mountain sucker	Golden trout	
	Northern leatherside chub*	Grayling	
	Paiute sculpin	Kokanee salmon	
	Redside shiner	Lake trout	
	Speckled dace	Rainbow trout	
	Utah chub		
	Utah sucker		

been considered a distinct, undefined, fine-spotted variety of cutthroat trout (Behnke 1992). Five fishes, including both subspecies of cutthroat trout, are considered Species of Greatest Conservation Need (SGCN). The two cutthroat subspecies have long been the focus of fisheries management efforts in the basin. Bluehead sucker, mountain whitefish, and northern leatherside chub are also SGCN. The distribution of northern leatherside chub within the Snake/Salt River basin is believed to be limited to a small portion of Pacific Creek. The Pacific Creek population is the only known population of this species in the Snake/Salt River basin in Wyoming and has persisted for at least 60 years.

No known native species have been extirpated from the watershed, but two introduced nongame species have been documented in the past decade. Fathead minnow was first documented in the Snake River below Jackson Lake Dam in 2002 and in the Lower Salt basin in 2003. A sucker specimen that was collected in the watershed and submitted to the Museum of Southwestern Biology in 2009 as a Utah sucker was confirmed by taxonomists and geneticists to be a white sucker. This is the first known occurrence of this species in the watershed.

Aquatic Reptiles

No turtles are native to the Snake/Salt River basin and none have been introduced.

Freshwater Mollusks and Crayfishes

Wyoming is still in the discovery phase in terms of its freshwater mussels and gastropods. Although fingernail and pill clams and aquatic gastropods are often encountered during invertebrate sampling, few published accounts exist (Beetle 1989, Henderson 1924, Hoke 1979, Hovingh 2004). Native mussel populations are present in every major drainage of Wyoming except the Green River basin and Great Divide closed basin. All native mussels, clams, and gastropods are considered SGCN by the WGFD due to a lack of information regarding status.

As of early 2010, seven species of native mussels were known to inhabit Wyoming waters, all of which are considered SGCN. A single species of mussel, the western pearlshell, is known to inhabit the Snake/Salt River basin. The species was first documented in the basin in Flat Creek (HUC 1704010302) in 1934. Since that time, the known distribution has been expanded to include the mainstem Snake (1704010105) and Salt (1704010503) rivers and a number of tributaries, including Crawfish Creek (1704010102), Polecat and Bearpaw creeks (1704010103), North Fork Slide and North Fork Fisherman creeks (1704010303),

and Flat (1704010302), Crow (1704010501), and Child (1704010503) creeks.

One biologist position on the Wyoming Game and Fish Department Aquatic Assessment Crew has been assigned to coordinate mollusk sampling and collect observations. Field personnel have been trained to record mussel observations during other routine fieldwork and submit specimens. A voucher specimen collection was established at the University of Colorado Natural History Museum in Boulder, Colorado, in 2007.

In 2009, the WGFD funded a project at the University of Wyoming to conduct a literature review, identifying the current and historical information on freshwater gastropod distributions in Wyoming and to develop gastropod collection methods for WGFD, and assess the distribution of freshwater gastropods in the Bighorn and North Platte River drainages in Wyoming. This project did not include any sampling in the Snake/Salt River basin, but one native species, the Jackson Lake springsnail, has been documented in the watershed. The nonnative New Zealand mudsnail has been introduced to the basin above Jackson Lake. This species is extremely abundant in Polecat Creek and has been found in relatively small numbers in the mainstem Snake River above Jackson Lake. Baseline survey data are needed for all gastropods in the Snake/Salt River basin.

The only crayfish species that has been documented in the Snake/Salt River basin is *Pacifasticus gambelii*. This is a native species found during both the 1985–1987 and 2007–2009 crayfish surveys (Hubert 1988, Hubert 2010). There is no evidence of the presence of non-indigenous crayfishes in the Snake River drainage.

Table 10. Species of Greatest Conservation Need present in the Snake/Salt River Basin

Fish
Bluehead sucker
Northern Leatherside chub
Mountain whitefish
Snake River cutthroat
Yellowstone cutthroat

Crustaceans
Pilose crayfish

Mollusks
Western pearlshell mussel
Jackson Lake springsnail

Identification of Conservation Areas

The Wyoming Game and Fish Department Strategic Habitat Plan (WGFC 2009) references multiple goals, two of which are to conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, and to enhance, improve, and manage priority wildlife habitats that have been degraded. Crucial habitat areas were identified to accomplish the first goal, and enhancement areas were identified to accomplish the second. Many of these areas are considered important conservation areas for aquatic SGCN in the Snake/Salt River basin (Figure 10).

Aquatic conservation priorities in the watershed include, but are not limited to, the mainstem Snake and Salt River corridors, spring streams tributary to these rivers, the lower reaches of Pacific Creek, and Snake and Salt River tributaries that sustain wild cutthroat populations free of nonnative species. Conservation areas are likely to be refined upon completion of the mussel, bluehead sucker, and northern leatherside chub projects described below in the section on Conservation Initiatives.

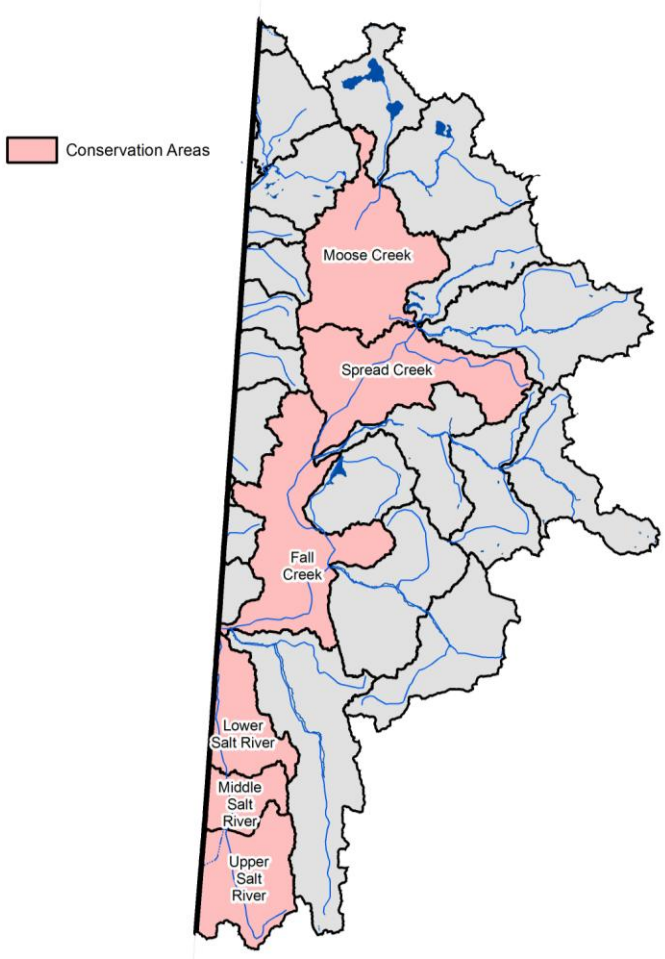

Figure 10. Aquatic Wildlife Conservation Areas in the Snake/Salt River Basin.

Threats

Water development/altered flow regimes – Moderate

Natural flow regimes in stream segments around the state have been altered by human activities, including irrigation diversions and water developments for enhanced water supply, hydropower, and flood control. These altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). The majority of the Snake/Salt River basin is publicly owned. However, the developed areas in the Salt River drainage severely fragment the watershed and limit fish movement, mainly through stream dewatering. Lateral and longitudinal hydrologic connectivity is reduced and fish populations are physically restricted from habitats necessary to complete their life history in many parts of the drainage.

The combined effects of Jackson Lake Dam and the levee system have altered flow regimes, instream habitat, and riparian function. Levees were initially used in the 1950s to protect private property and now constrain the Snake River from Grand Teton National Park to south of Jackson. Jackson Lake Dam has altered flow regimes and blocked fish passage since the early 1900s. Outside the levees, spring creeks and cottonwood regeneration have been negatively affected by lack of flooding.

While water development can threaten native species, some introduced species, including popular sport fisheries, have thrived in the face of water development. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements. For example, the lake trout fishery in Jackson Lake Reservoir depends on the consistent deep water and forage production inherent in this man-made water body. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive sport fisheries like that found in the Snake River tailwater.

Residential development throughout the Snake River, Flat Creek and Salt River valleys are directly influencing groundwater levels and important spring creeks. These developments often include ponds. Together, groundwater pumping and pond development have the potential to negatively impact water temperatures, levels, and quality in spring streams which serve as spawning and rearing areas for Snake River cutthroat trout.

Altered flow regimes from vegetational succession occur in watersheds like the Greys River where fire suppression has resulted in a lack of community and age class diversity. Conducting watershed scale vegetation treatments has become an important tool for enhancing wildlife both terrestrial and aquatic. For example, aspen treatment projects in the Greys River drainage have the potential to increase water yield and improve spawning and migration of native fish.

Drought and climate change – Moderate
Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and runoff, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004). Drought lowers water tables, leading to reduced plant growth and reproduction. Riparian vegetation declines lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels increase water temperatures and reduce habitat available to fish and other aquatic wildlife. All these conditions can be detrimental to the health and reproductive success of all aquatic wildlife species.

Invasive species – Moderate
The primary threats from invasive species in the Snake/Salt River watershed are from hybridization with rainbow trout or other cutthroat subspecies. The recent documentation of white sucker in the drainage poses similar risks of hybridization with native sucker species in the drainage, particularly bluehead sucker.

Competition with nonnative brook trout is a localized concern, particularly in headwater streams and some spring creeks.

Although no population level effects have been observed, *Myxobolus cerebralis* is prevalent in the Salt River drainage and is present in the Snake River drainage.

Aquatic invasive species (AIS) including fish, pathogens, plants, and mollusks are currently present in Wyoming, most notably the New Zealand mudsnail and the parasite that causes whirling disease. These AIS can alter the native species in a watershed through competition, disease, shifts in food availability, and direct mortality. While AIS currently in Wyoming can cause problems and need to be controlled, the most significant known threat to Wyoming's native species is from zebra and quagga mussels, based on their proximity to Wyoming and demonstrated negative impacts in other areas. Zebra and quagga mussels can out-compete native mussels for space and resources and will attach to and smother native mussels causing mortality (Cummings and Mayer 1992, Strayer 2008). They filter plankton out of the water column at high rates (up to a liter per day per individual) so that little plankton remains available for fish populations, resulting in their

decline (Benson 2009). In addition, invasive mussels produce pseudofeces which can lead to harmful algal blooms affecting numerous aquatic species.

The Wyoming Aquatic Invasive Species Act of 2010 allowed the WGFD to implement the Wyoming AIS Program with the goal of executing a coordinated strategy to prevent, control, contain, monitor, and whenever possible, eradicate aquatic invasive species from the waters of the state. The Wyoming AIS Management Plan of 2010 is the framework for this three-part strategy which includes 1) outreach and education, 2) inspection of watercraft to increase boater awareness of AIS threats and prevention and to intercept high risk watercraft that may be transporting AIS, and 3) monitoring of waters to allow for early detection and rapid response to any new AIS populations in the state.

Conservation Initiatives

The 2009 designation by Congress of 407 miles of Wyoming's rivers as Wild and Scenic includes the Snake River upstream of Moose, WY, and between Hoback Junction and Palisades Reservoir. It also includes portions of more than a dozen tributaries, including Pacific Creek, Buffalo Fork, Gros Ventre, and Hoback Rivers. This designation protects riparian land along both sides of a river corridor, and preserves a river's free-flowing nature. The designation also prohibits federal support for actions such as the construction of dams or other instream activities that would harm the river's free-flowing condition, water quality, or outstanding resource values.

Studies of relationships between stream flow and habitat for Snake River cutthroat trout have been ongoing in the Hoback River drainage from 2008 to 2010. Additional studies in the Greys River drainage are planned for 2011 and beyond. These studies will form the basis for the development of flow recommendations for instream flow water rights applications. Instream flow water rights on various stream segments, if granted by the State Engineer, will be held by the State of Wyoming and serve to maintain identified stream flows needed for Snake River cutthroat trout habitat. Fisheries management in the Snake/Salt River basin focuses on establishing and maintaining naturally-reproducing populations of wild game species and conserving nongame species. Stocking is limited to standing water, and important spring streams are stocked with eyed eggs to augment or establish spawning populations. Electrofishing gear is used to protect the Snake River cutthroat population by removing nonnative rainbow trout and rainbow–cutthroat hybrids from Laker Spring in the Salt River drainage. Stocking of nonnative lake trout in Jackson Lake was phased out between 2004 and 2007 because of poor condition of lake trout and other species, relatively poor lake trout return to the creel, and an emphasis on native species management.

WGFD biologists continue to work actively with partners to improve fish passage through the spring creeks corridor south of Jackson and throughout the Salt River drainage to improve connectivity in important spawning tributaries in the watershed. Recently, an irrigation dam was removed from Spread Creek reestablishing connectivity to over 40 miles of habitat. Multiple projects have been completed in the Salt River drainage to stabilize stream banks and restore riparian willow communities.

Two new projects focusing on SGCN in the Snake/Salt River basin were initiated in 2010. The first project, funded by the Wyoming Governor's Office, will describe the distribution, seasonal movements, age and growth, and disease susceptibility of bluehead suckers within the Upper Snake River watershed. The second project, funded by the State Wildlife Grants (SWG) program, will determine the current distribution of northern leatherside chub (LSC) in Wyoming. The distribution of this species is primarily within the Bear River drainage in Wyoming, but the study area will include the Pacific Creek watershed in the Snake/Salt River basin. A population of LSC has inhabited the Pacific Creek watershed for at least 60 years. The

objectives of this project are to 1) determine baseline abundances for major populations of LSC chub in Wyoming, 2) identify species of fish sympatric with LSC in Wyoming, 3) identify relationships between LSC distributions and habitat characteristics, and 4) collect tissue samples from major LSC populations in Wyoming for genetic analyses. WGFD biologists are collaborating with Brigham Young University (BYU) and Idaho State University researchers on this project. A BYU project will address objective 3 above. The genetic analysis will be completed as part of a master's degree project through Idaho State University (objective 4 above).

Bluehead sucker and northern leatherside chub are both considered Native Species Status 1 by the WGFD, indicating that populations are isolated and/or exist at low densities, and habitat for these species is declining or vulnerable. These projects will result in recommended conservation actions to ensure the long-term persistence of these species in the Snake/Salt River basin in Wyoming.

A third SWG-funded project, to be initiated in spring 2011, will determine baseline distributions and status of freshwater mussel species in the Snake/Salt River basin in Wyoming. The specific objectives of this project are to 1) establish mussel distribution and habitat survey methods appropriate for use throughout Wyoming, 2) establish species distributions and identify core populations of mussels, 3) contribute to a comprehensive collection of mussel voucher specimens at the University of Colorado Museum, and 4) evaluate the need for population monitoring and propose management recommendations.

The WGFD's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction for sportfish, SGCN, and aquatic habitat. The management direction includes reference to the SWAP and the Strategic Habitat Plan, attempting to incorporate management direction from those two plans that is relevant to each basin into each basin management plan.

The WGFD has the opportunity to comment on most environmentally sensitive construction or management actions submitted through the National Environmental Policy Act (NEPA) review process. Projects include state and federal lands and private ventures that require action by state or federal agencies. The WGFD regularly provide recommendations to protect habitat and populations of aquatic wildlife at the project level. Department efforts are guided by Wyoming Game and Fish Commission mitigation policy (WGFC 2008).

The WGFD has a rigorous collection permitting system that restricts commercial, scientific, and educational collection activities in order to protect aquatic wildlife (WGFC 2005a). The regional fisheries supervisor reviews all requests for permits and recommends either approval or rejection of the request based on merit and impacts to the resource in question.

The movement of fish by WGFD employees is critical to address many of the aspects, thus the intent, of our mission. However, the act of moving or importing fish also presents risks with the potential to jeopardize that mission. To address this conflict, a method to determine the relative level of risk associated with any proposed fish importation and/or transplant was developed. The WGFD utilizes Hazard Analysis and Critical Control Point (HACCP) procedures (Gunderson and Kinnunen 2001) and has developed a Risk Assessment Matrix from these procedures to manage transplants, thereby protecting the aquatic resources within the state. Using the procedures and matrix, WGFD fisheries managers develop documentation that explains whether a proposed transplant is nearly free of risk. The documentation must address all aspects of the transplant including, but not limited to, verifying that the fish being transplanted are disease free, the water source is disease free, and non-target species are excluded from transplant. Source populations of salmonids are verified disease free by collecting a standardized number of fish, having them inspected by an American

Fisheries Society-certified Fish Health Inspector for all known pathogens, and receiving disease free certification. The resulting documentation is reviewed and either approved or denied by the WGFD Chief of Fisheries. No whirling disease-infected trout, native or nonnative, are stocked by the WGFD, and they are not allowed to be stocked by others (WGFC 2003).

In Wyoming, Game and Fish Commission policy precludes the stocking of fish into waters that are capable of satisfactory, self-sustaining fisheries (WGFC 1998). A commonsense, biologically based protocol for fish rearing and stocking has historically been followed in Wyoming, with emphasis on management for native fish and wild fish wherever possible (Wiley 1995). Only 3% of the streams listed in the Wyoming Game and Fish Department database inventory are stocked annually, none of which are in the Snake River drainage. Maintenance of native cutthroat trout subspecies has been a management priority for more than 40 years (Stone 1995), and protection from stocked predators of native nongame fishes has been an important consideration for at least the last decade.

Wyoming has regulations prohibiting unauthorized stocking of fish or fish eggs. Private citizens can only stock waters in Wyoming following a WGFD permitting system that includes review by the responsible regional fisheries supervisor (WGFC 2005b). The WGFD has increased education efforts regarding the problems associated with illegal introductions of fish. The Wyoming Legislature increased the penalties for illegal fish stocking in 2010, and the Wyoming Wildlife Protectors Association has offered $2,500 rewards for information leading to the conviction of individuals found illegally moving or stocking fish.

Habitat management efforts are guided by the Strategic Habitat Plan (SHP) that was adopted by the Wyoming Game and Fish Commission in January 2009. The SHP includes five goals: 1) Conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, 2) Enhance, improve, and manage priority wildlife habitats that have been degraded, 3) Increase wildlife-based recreation through habitat enhancements that maintain or increase productivity of wildlife, 4) Increase public awareness of wildlife habitat issues and the critical connection between healthy habitat and abundant wildlife populations, and 5) Promote collaborative habitat management efforts with the general public, conservation partners, private landowners, and land management agencies. Efforts are focused in priority areas in each of the management regions and include crucial areas essential for conservation of important species and communities and enhancement areas, which represent places where work should be conducted to manage or improve wildlife habitat.

Habitat enhancement activities in the Snake/Salt basin in recent years have focused on narrowing spring streams to restore sediment transport capacity and enhance migration corridors and spawning gravel for Snake River cutthroat trout (for example, see WGFD 2010). Additional aquatic habitat restoration and enhancement activities include reducing bank erosion and improving riparian vegetation through sod and willow plantings, grazing management, and stream structures. In the Greys River basin, watershed management has emphasized improving vegetation diversity and vigor using prescribed fire. Beaver translocations are occurring to encourage colonies in areas with sufficient lodge, dam, and forage resources and thereby improve water retention high in several drainages.

The Wyoming Legislature created the Wyoming Wildlife and Natural Resource Trust (WWNRT) in 2005. Funded by donations, legislative appropriation, and interest earned on a permanent account, the purpose of the program is to enhance and conserve wildlife habitat and natural resource values throughout the state. Any project designed to improve wildlife habitat or natural resource values is eligible for funding. The WWNRT is an independent state agency governed by a nine-member citizen board appointed by the Governor. The WGFD has

partnered with the WWNRT to successfully implement a wide range of projects to benefit a broad array of Wyoming's wildlife.

Landscape Conservation Cooperatives (LCCs) are a new program of the U.S. Fish and Wildlife Service. The vision is that they serve as applied conservation science partnerships focused on a defined geographic area that inform on-the-ground strategic conservation efforts at landscape scales. LCC partners include U.S. Department of Interior agencies, other federal agencies, states, tribes, non-governmental organizations, universities, and other stakeholders. It is hoped that LCCs will enable resource management agencies and organizations to collaborate in an integrated fashion within and across landscapes. LCCs are intended to provide scientific and technical support to inform landscape-scale conservation using adaptive management principles. They are proposed to engage in biological planning, conservation design, inventory and monitoring program design, and other types of conservation-based scientific research, planning, and coordination. It is hoped that LCCs will play an important role in helping partners establish common goals and priorities, so they can be more efficient and effective in targeting the right science in the right places. Products developed by LCCs should inform the actions of partners and other interested parties in their delivery of on-the-ground conservation. The WGFD will continue to participate in the LCC process as appropriate.

The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. In its design, the plan encompasses five important lessons that emerge from America's past efforts to protect and restore fish habitat: 1) Be strategic rather than merely opportunistic, 2) Address the causes of and processes behind fish habitat decline, rather than the symptoms, 3) Provide increased and sustained investment to allow for long-term success, 4) Monitor and be accountable for scientifically sound and measurable results, and 5) Share information and knowledge at all levels from local communities to Congress. The Wyoming Game and Fish Department has been heavily involved with the development and implementation of the NFHAP. The WGFD is involved with three NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative and the Desert Fishes Habitat Partnership. The Western Native Trout Initiative is the only partnership to cover the Snake/Salt River basin.

The mission of the Western Native Trout Initiative (WNTI) is: "To serve as a key catalyst for the implementation of conservation or management actions, through partnerships and cooperative efforts, resulting in improved species status, improved aquatic habitats, and improved recreational opportunities for native trout anglers across western states." Their vision is: "An increase in healthy, fishable western native trout populations resulting from sharper focus and commitment to action on common conservation needs of western native trout; enhanced public benefit resulting from multiple partners working together, sharing resources, and speaking with a united voice about the conservation and value of western native trout; and increased funding to accomplish strategic actions as a result of greater community and financial support from initiative partners and collaborators." By working together, the partners in WNTI are striving to implement the most strategic actions needed to benefit these trout. And by working together to establish secure populations, WNTI will also benefit anglers by enhancing recreational fishing opportunities for unique trout species across the West.

The states of Idaho, Montana, Nevada, Utah, and Wyoming, along with the U.S. Forest Service and Grand Teton and Yellowstone National Parks, signed a Memorandum of Agreement to jointly conserve, protect, and restore Yellowstone cutthroat trout populations within their historic range in 2000 and updated it in 2009 (Range-wide YCT Conservation Team

2009). This agreement has significantly advanced range-wide conservation and management efforts. The most notable accomplishment of the Yellowstone Cutthroat Trout Interstate Workgroup, working under the auspices of the 2000 Memorandum of Agreement, is the completion of a range-wide status assessment (May et al. 2003, 2007). The status assessments used the best scientific information available, and a strict decision-making protocol was conducted by teams of experts with the best information and background to perform the assessment. This effort produced the best estimate of current and historic range ever developed.

An active conservation and management program for northern leatherside chub has developed in the last several years. One of the most important recent accomplishments is that the states of Idaho, Nevada, Utah, and Wyoming, along with the U.S. Forest Service, Bureau of Land Management, Bureau of Reclamation, National Park Service, Fish and Wildlife Service, Trout Unlimited, and The Nature Conservancy, signed a Conservation Agreement to jointly conserve, protect, and restore northern leatherside chub populations within their historic range (UDWR 2009). This agreement has already begun advancing range-wide conservation and management efforts.

Recommended Conservation Actions

Protect and enhance Snake River tributary streams.
While a large percentage of the basin is in public ownership, development of riparian areas is a growing concern. Cooperation with private landowners will be crucial for minimizing potential impacts. The cumulative contribution of connected habitats, including spring creek spawning areas on deeded lands, is key to maintaining Snake River cutthroat trout populations. Kiefling (1997) summarizes the history of the Snake River spring creek spawning tributaries: "Long-term maintenance of spring creek systems within Teton County will continue to be a problem due to economics and commercial development of riparian lands."

Secure and enhance populations and habitats in SGCN priority areas.
Evaluate the feasibility of reducing populations of or removing nonnative fishes from priority conservation areas in the basin.

Complete ongoing studies and instream flow water rights filings under the WGFD water management five-year plan to protect important cutthroat trout fisheries.

Continue to develop stream and riparian enhancement projects with private landowners and public land managers to improve spawning gravels, migration routes, and instream habitat for Snake River cutthroat trout in Snake River and Salt River tributaries.

Enhance spawning runs of Snake River cutthroat trout.
Stock eyed–Snake River cutthroat trout eggs in select Salt River spring streams to develop naturally reproducing populations of wild fish.

Remove fish passage obstacles.
Continue identifying barriers to spawning Snake River cutthroat trout in the Snake/Salt River Basin spring streams and developing passage solutions.

Identify screening priorities to reduce fish loss to diversions.

Evaluate the status and distribution of native aquatic wildlife assemblages with emphasis on Snake River cutthroat trout, bluehead sucker, and northern leatherside chub.
Continue basin-wide surveys to identify fish distribution, relative abundance, and habitat preferences.

Continue to assist the SWG LSC biologist with project development and data collection.

Assist Mark Belk (BYU) and John Henderson (BLM) with BYU LSC research project development and data collection.

Complete bluehead sucker project to evaluate distribution, habitat associations, and develop management recommendations.

Identify and reduce threats to native fish populations from nonnative species.
While the overall health of the native aquatic assemblage in the Snake/Salt River basin is strong, there are many localized populations of exotic fish species. These populations pose a threat to the indigenous fishery through competition (brook trout, brown trout, and lake trout) and hybridization (rainbow trout and white sucker). The current status and impacts of exotic populations is poorly understood in some portions of the basin and merits further investigation.

Continue to remove rainbow trout and cutthroat–rainbow hybrids from Laker Spring in the Salt River drainage and the Gros Ventre River.

Implement existing plans and agreements to conserve SGCN.
Represent the WGFD on the interagency Three Species conservation team and help implement the Range-wide Conservation Agreement and Strategy for the Three Species (Colorado River Fish and Wildlife Council 2004).

Represent the WGFD on the interagency Yellowstone cutthroat trout conservation team and help implement the Range-wide Conservation Agreement and Strategy for Yellowstone cutthroat trout (Range-Wide YCT Conservation Team 2009).

Represent the WGFD on the interagency northern leatherside chub conservation team and help implement the Range-wide Conservation Agreement and Strategy for Northern Leatherside (UDWR 2009).

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN.
The importance and role of aquatic SGCN is poorly understood by the general public. Efforts should be enhanced to increase public education in this area.

Continue aquatic habitat work in the basin.
Continue to work with land managers to plan and conduct watershed scale vegetation treatments.

Continue to improve natural stream form and function to favor native aquatic species.

Supply flow or other information to the State Engineer's Office and Water Development Office to facilitate adjudication of instream flow water rights.

Monitor instream flow segments for compliance with approved instream flow levels. Pursue compliance as needed when water is available and in priority.

Explore water management approaches that enhance fish habitat.
Identify opportunities to work with private water right holders to manage water diversions and uses with the goal of restoring natural flow regimes. Where opportunities exist, develop cooperative strategies with landowners and other partners to implement strategies that are beneficial to aquatic resources.

Identify fish and wildlife mitigation for new reservoirs as they are proposed including instream flow regimes and minimum fishery pools. Ensure that mitigation recommendations are included as conditions in applicable permits.

Continue building voucher collections for all aquatic wildlife.
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear, 2009).

Mussel specimens have been donated to the University of Colorado Museum, and new specimens will be added as needed. A database containing freshwater mussel occurrences will be maintained and enhanced with specimen photos.

Determine if there is interest in voucher specimens of gastropods. If so, expand the voucher program to include those organisms.

Complete the comprehensive survey for freshwater mussels

Describe the distributions and habitat associations of western pearlshell and gastropods in the watershed.

Future efforts will focus on filling gaps in distribution information, initiating comprehensive drainage surveys, maintenance of department records, and expansion of specimen collections.

Follow up on recommendations from the graduate research project on gastropods.
The WGFD-funded graduate project at the University of Wyoming will provide direction for sampling methods. Those recommendations should be followed, and baseline gastropods surveys should be conducted in the Snake River basin.

Monitoring

Continue routine monitoring of Snake River cutthroat trout.
Monitor Snake River cutthroat trout spawning activity in important spring creeks tributary to the Snake and Salt Rivers.

Routinely monitor SRC populations in the mainstem Snake and Salt Rivers and important spawning tributaries. Continue monitoring the response of the wild SRC population in streams that are no longer stocked.

Establish standardized monitoring protocols and locations for native SGCN.
Routinely monitor northern leatherside chub populations in Pacific Creek.

Monitor known western pearlshell mussel populations to evaluate habitat preference and abundance.

Monitor water resource impacts associated with human developments
Monitor water quantity and quality in spring streams associated with pond development and groundwater pumping.

Literature Cited

ABELL, R. AND 27 OTHER AUTHORS. 2008. Freshwater ecoregions of the world: a new map of biogeographic units for freshwater biodiversity conservation. BioScience 58(5):403–414.

BAILEY, R. G. 1995. Descriptions of the ecoregions of the United States. US Forest Service. Miscellaneous Publication No. 1391.

BARNETT, T., R. MALONE, W. PENNELL, D. STAMMER, B. SEMTNER AND W. WASHINGTON. 2004. The effects of climate change on water resources in the West: introduction and Overview. Climatic Change 62: 1–11.

BEETLE, D. E. 1989. Checklist of recent Mollusca of Wyoming. Great Basin Naturalist 49(4): 637–645.

BEHNKE, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6.

BENSON, A. J. 2009. Zebra mussel sightings distribution. Retrieved April 17, 2009 from http://nas.er.usgs.gov/taxgroup/mollusks/zebra mussel/zebramusseldistribution.asp.

CHAPMAN, S. S., S. A. BRYCE, J. M. OMERNIK, D. G. DESPAIN, J. ZUMBERGE, AND M. CONRAD. 2004. Ecoregions of Wyoming (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

COLORADO RIVER FISH AND WILDLIFE COUNCIL. 2004. Rangewide conservation agreement for roundtail chub *Gila robusta*, bluehead sucker *Catostomus discobolus*, and flannelmouth sucker *Catostomus latipinnis*. Utah Department of Natural Resources, Salt Lake City.

COMER, P., D. FABER-LANGENDOEN, R. EVANS, S. GALWER, C. JOSSE, G. KITTEL, S. MENARD, M. PYNE, M. REID, K. SCHULZ, K. SNOW, AND J. TEAGUE. 2003. Ecological systems of the United States: a working classification of U.S. terrestrial systems. NatureServe, Arlington, VA.

CUMMINGS, K. S., AND C. A. MAYER. 1992. Field guide to freshwater mussels of the Midwest. Illinois Natural History Survey Manual 5.

CURTIS, J. AND K. GRIMES. 2004. Wyoming Climate Atlas. http://www.wrds.uwyo.edu/sco/climateatlas/toc.html.

GUNDERSON, J.L., AND R.E. KINNUNEN. Editors. 2001. Sea Grant Aquatic Nuisance Species. Hazard Analysis and Critical Control Point Training

Curriculum Minnesota Sea Grant Publication Number: MNSG-F11, Minnesota Sea Grant, 2305 E 5th Street, Duluth, Minnesota.

HENDERSON, J. 1924. Mollusca of Colorado, Utah, Montana, Idaho and Wyoming. University of Colorado Studies 13:65–223.

HIGGINS, J. V., M. T. BRYER, M. L. KHOURY, T. W. FITZHUGH. 2005. A freshwater classification approach for biodiversity conservation planning. Conservation Biology 19:432–445.

HOKE, E. 1979. Wyoming mussel distributions as revealed by survey activities conducted during the summer of 1978. Wyoming Game and Fish Department, Cheyenne, WY.

HOVINGH, P. 2004. Intermountain freshwater mollusks, USA (Margaritifera, Anodonta, Gonidea, Valvata, Ferrissia): geography, conservation, and fish management implications. Monographs of the Western North American Naturalist 2:109–135.

HUBERT, W. A. 1988. Survey of Wyoming crayfishes. Great Basin Naturalist 48:370–372.

HUBERT, W. A. 2010. Survey of Wyoming crayfishes: 2007–2009. US Geological Survey Report to the Wyoming Game and Fish Department, Cheyenne, WY.

KIEFLING, J. 1997. A history of Snake River Spring Creek spawning tributaries. Wyoming Game and Fish Department Administrative Report, Cheyenne, WY.

KNIGHT, D. H. 1994. Mountains and plains—the ecology of Wyoming landscapes. New Haven, Connecticut, Yale University Press.

MAY, B. E., W. URIE, AND B. B. SHEPARD. 2003. Range-wide status of Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*): 2001. USDA Forest Service, Gallatin National Forest, Bozeman, MT.

MAY, B., S. E. ALBEKE, AND T. HORTON. 2007. Range-wide status of Yellowstone cutthroat trout (*Oncorhynchus clarkii bouveri*): 2006. Yellowstone Cutthroat Trout Conservation Team Report. Montana Fish, Wildlife and Parks, Helena, MT.

NATURESERVE. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer.

NORTHWEST GAP ANALYSIS PROJECT. 2010. http://gap.uidaho.edu/index.php/gap-home/Northwest-GAP accessed July 2, 2010.

RANGE-WIDE YCT CONSERVATION TEAM. 2009. Conservation agreement for Yellowstone cutthroat trout (Oncorhynchus clarkii bouvieri) in the States of Idaho, Montana, Nevada, Utah and Wyoming. Montana Fish, Wildlife & Parks.

SEAVY, N. E. T. GARDALI, G. H. GOLET, F. T. GRIGGS, C. A. HOWELL, R. KELSEY, S. L. SMALL, J. H. VIERS, AND J. F. WEIGAND. 2009. Why climate change makes riparian restoration more important than ever: recommendations for practice and research. Ecological Restoration 27:330-338.

SIMON, J. R. 1951. Wyoming Fishes (revised). Wyoming Game and Fish Department Bulletin Number 4. Cheyenne.

SIMONDS, W. J. 1996. The Palisades Project. U.S. Bureau of Reclamation. http://www.usbr.gov/projects//ImageServer?imgName=Doc_1245095449207.pdf. Accessed November 22, 2010.

SNAKE/SALT RIVER BASIN WATER PLAN FINAL REPORT. 2003. Wyoming Water Development Office. http://waterplan.state.wy.us/ accessed on-line July 2010.

STONE, M.D. 1995. Fish stocking programs in Wyoming: a balanced perspective. American Fisheries Society Symposium 15:47-51.

STRAYER, D. L. 2008. Freshwater mussel ecology. University of California Press, Los Angeles.

U.S. ARMY CORPS OF ENGINEERS. July 2000. Jackson Hole, Wyoming environmental restoration feasibility report. Feasibility Report and Environmental Assessment.

UDWR 2009 Rangewide conservation agreement and strategy for northern leatherside (*Lepidomeda copei*). Utah Division of Wildlife Resources, Salt Lake City, UT.

WGFD. 2009. Strategic Habitat Plan. Wyoming Game and Fish Department, Cheyenne, WY.

WGFD. 2010. 2009 Annual report strategic habitat plan accomplishments. Wyoming Game and Fish Department, Cheyenne, WY.

WILEY, R.W. 1995. A common sense protocol for the use of hatchery-reared trout. American Fisheries Society Symposium 15:465-471.

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY. 2010. Wyoming water quality assessment and impaired waters list (2010 Integrated 305(b) and 303(d) Report). Wyoming Department of Environmental Quality Document #10-0230.

WYOMING GAME AND FISH COMMISSION. 1998. Fish Stocking Policy. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2003. Chapter 10: Regulation for importation, possession, confinement, transportation, sale and disposition of live wildlife. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2005a. Chapter 33: Issuance of scientific research, educational or special purpose permits. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2005b. Regulation governing private fish stocking. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2008. Mitigation policy. Cheyenne, WY.

WYOMING GAME AND FISH COMMISSION. 2009. Strategic Habitat Plan. Cheyenne, WY.

ZAFFT, D.J. AND E.A. BEAR. 2009. Guidelines for the collection of fish voucher specimens. Wyoming Game and Fish Department Administrative Report, Cheyenne, WY.